

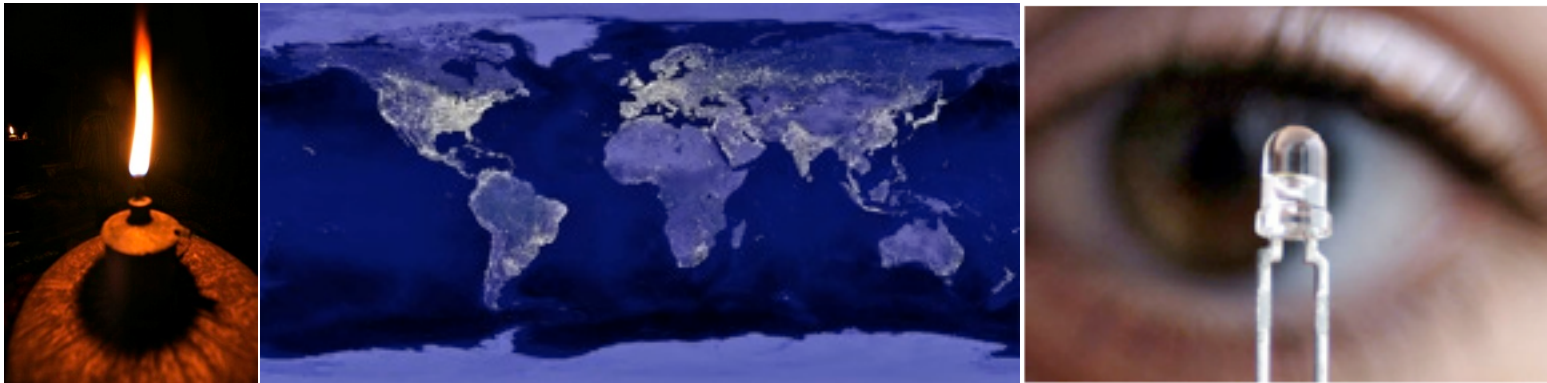
Illuminating the Developing World

Rosenfeld Symposium:

The Next Generation of Energy Efficiency

UC Davis Robert and Margrit Mondavi Center for the Performing Arts

March 9, 2010

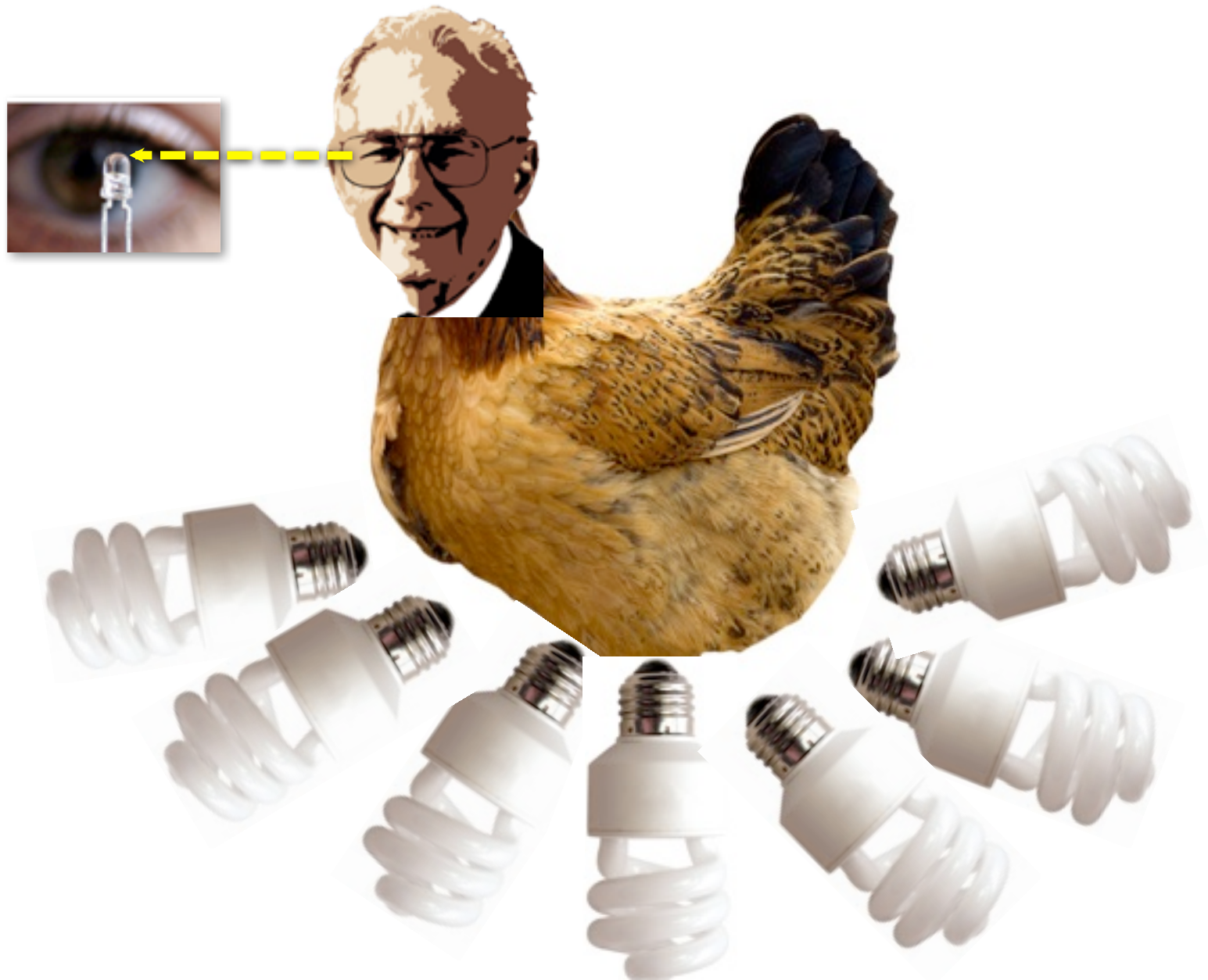


Evan Mills, Ph.D.

Lumina Project

Lawrence Berkeley National Lab

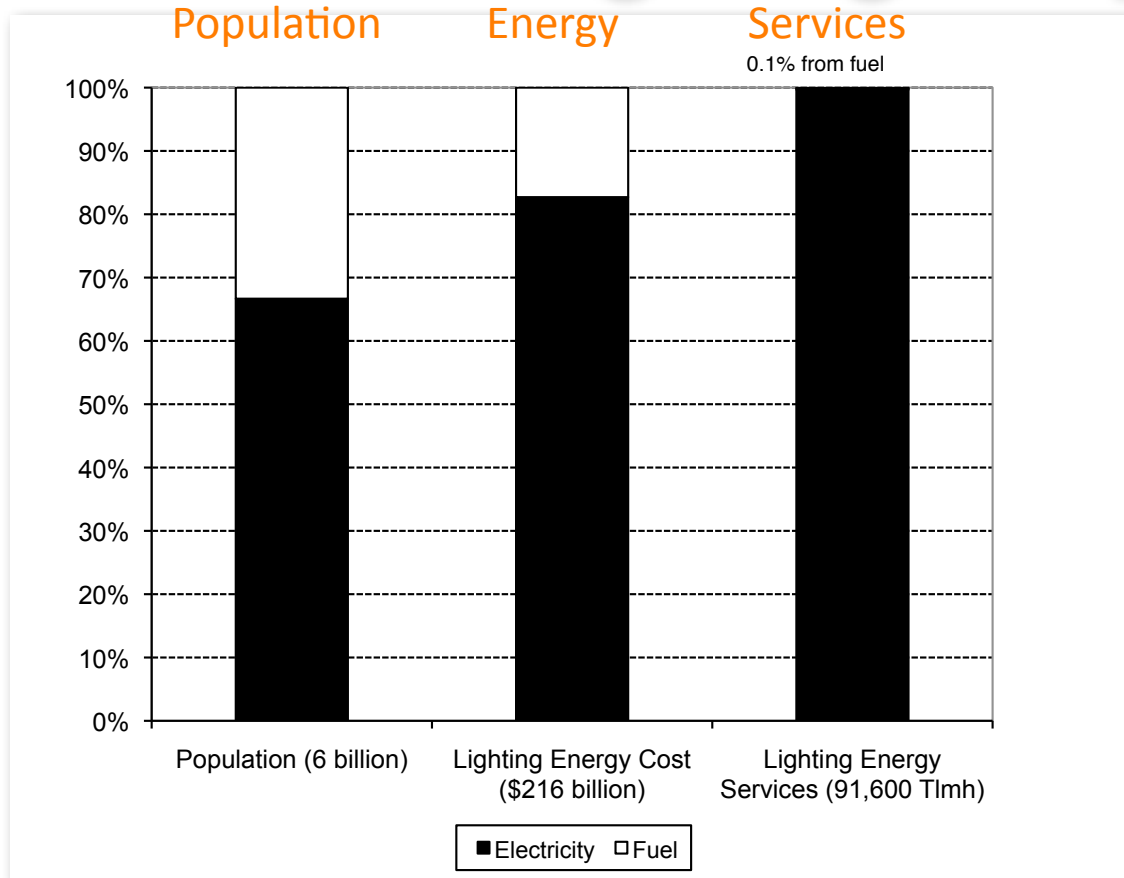
The Rosenfeld Incubator





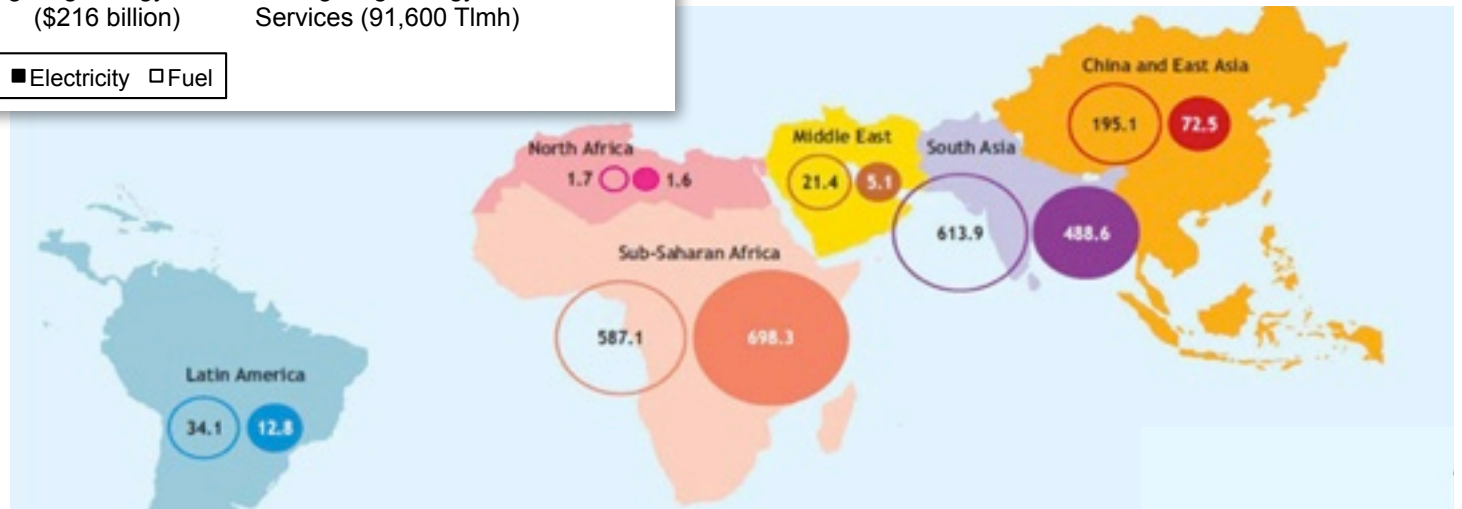
India: street vendor
(Varanasi)

Lighting Inequities



- 1.5 billion people
- \$40 billion in fuel
- 0.01% of global services
- 190 MTCO₂ = 30M cars

Source: Mills, E. 2005.
 "The Specter of Fuel-
 Based Lighting," *Science*
 308:1263-1264



The human dimension



Not only household uses....



Tanzania: street vendors
(Dar es Salaam)

Tin lantern:

\$0.20 to buy \$50/year to operate



Kenya: Tin lamp shop
(Kibera)

Flames v. LEDs: like night & day

Flame



LED

Flame: 0.1 lumens/watt • 1-10 lux



LED: 50 lumens/watt • 100-500 lux



Tanzania: street vendor (Dar es Salaam)

User-centered design



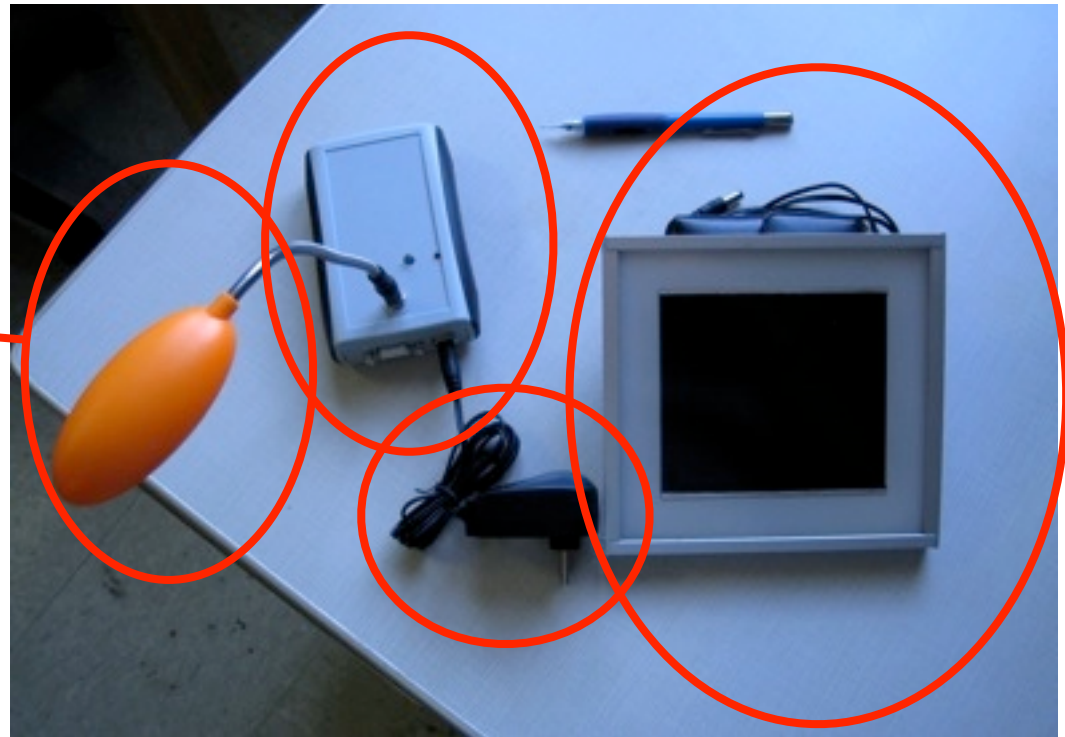
Lab testing



Simple technology; Complex systems

Battery & Circuitry

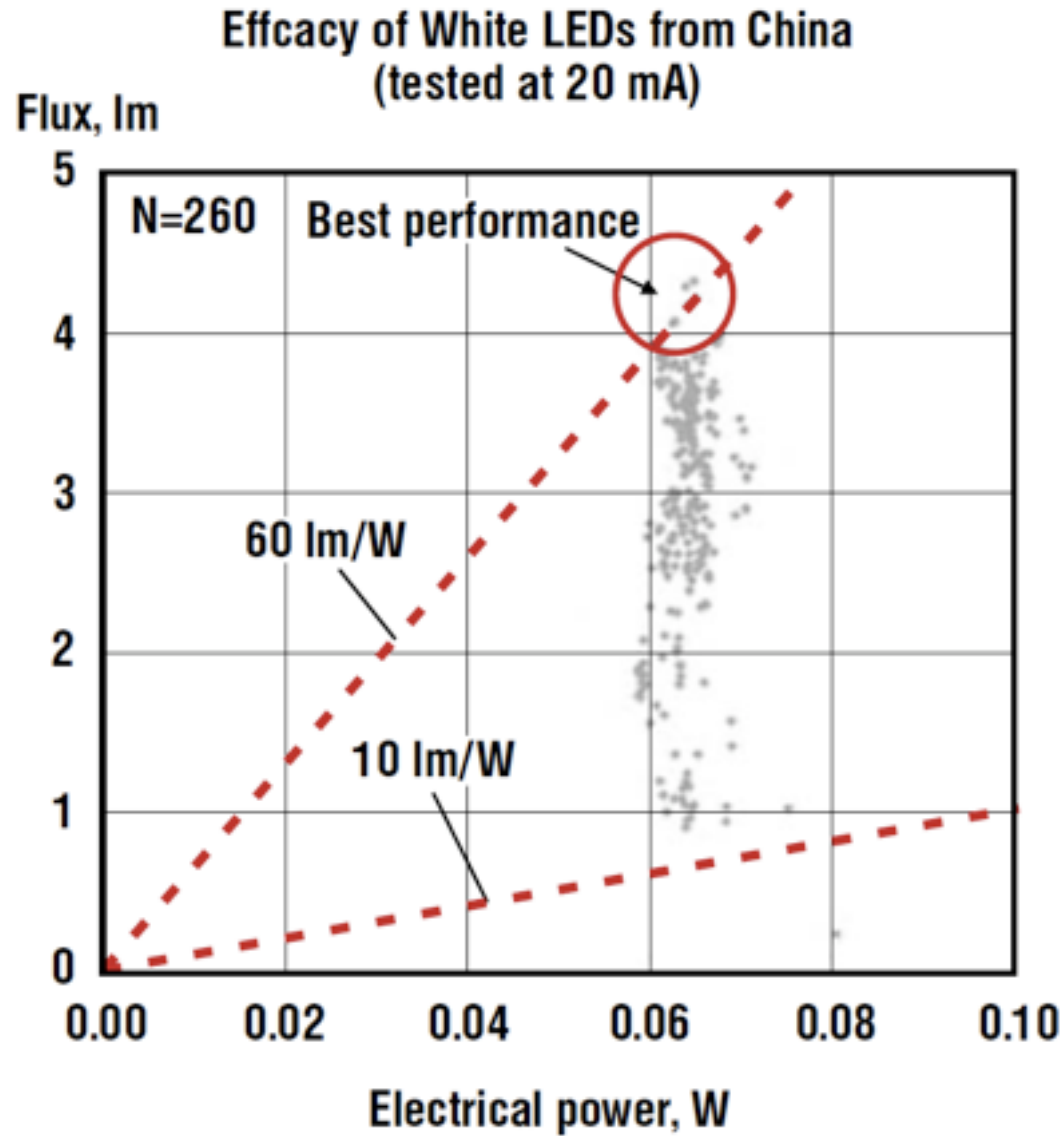
LED or CFL



Switches, Housing,
Wires, Connectors, etc.

Power Source
(solar, AC, dynamo)

Many products perform badly in the lab.....



Source: Lumina Project (LBNL/HSU)

... and many fail completely in the field



End users report failure due to:

- LED quality
- Water leakage
- Breakage
- Short battery life
- Counterfeit

→ *Market Spoiling*



Market tests

- Offered *viable* products, based on testing
- Used existing market & sales channels
- Set real world prices (no subsidy)
- 50 systems sold to homes & businesses



→ **No buyers took offer
For 100% refund**

Night vendor test (26 shops)



“The LED is safer than kerosene...

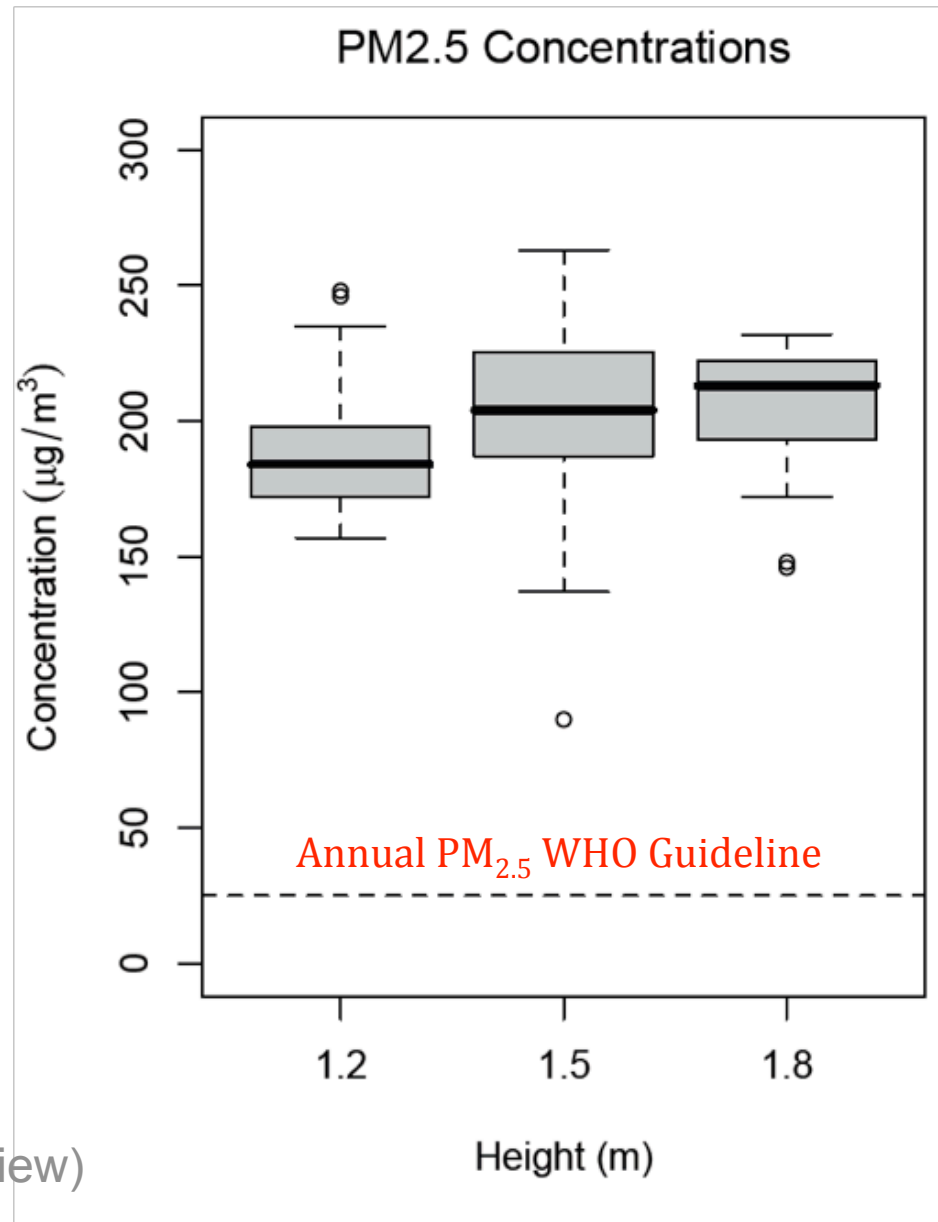
My customers have increased...

My revenue has increased...”

- MJ



Indoor particulate concentrations



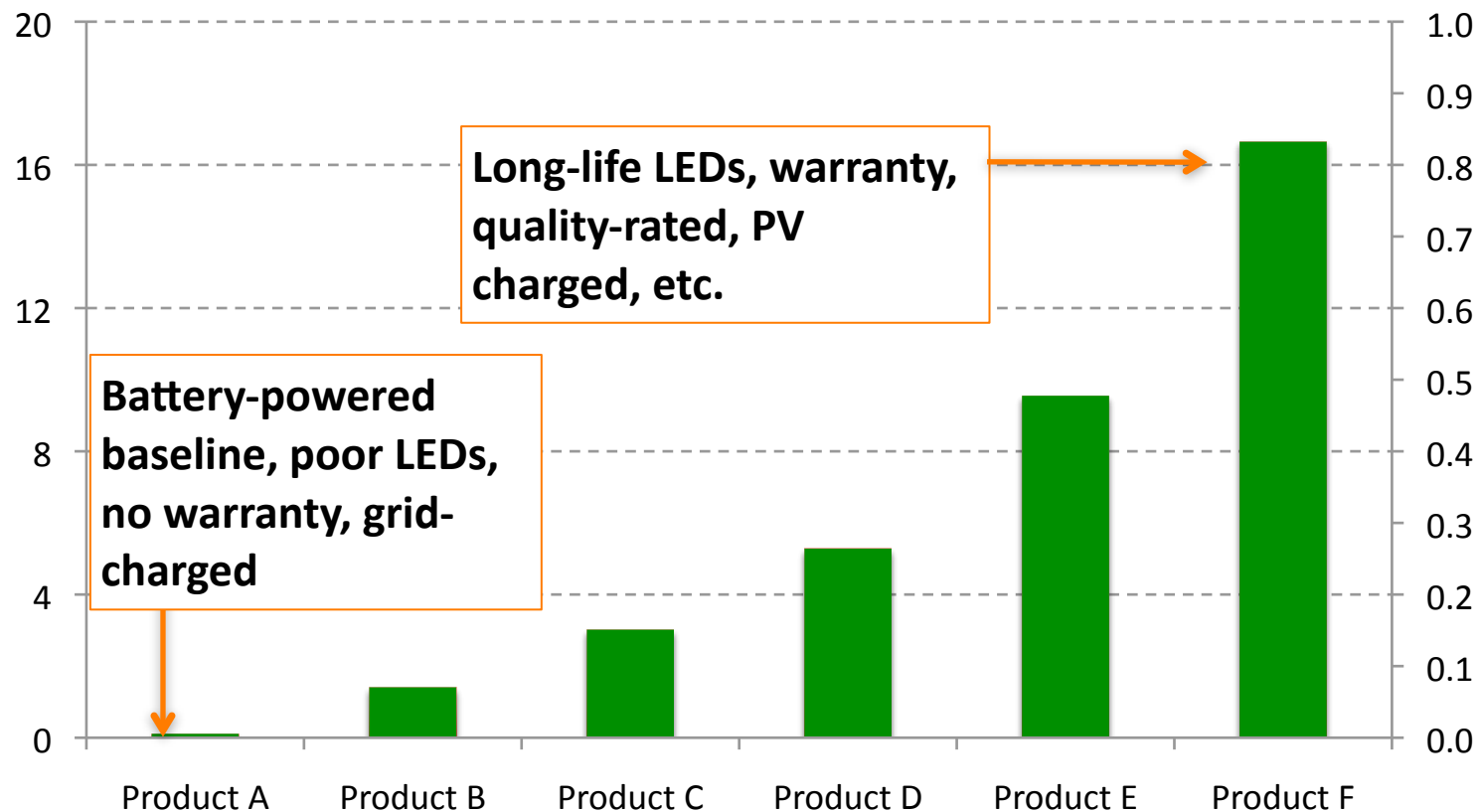
Source: Poppendieck, *et al.* 2009 (in review)

Recommendations to UNFCCC on CDM methodology

Value of
carbon offset
(\$)

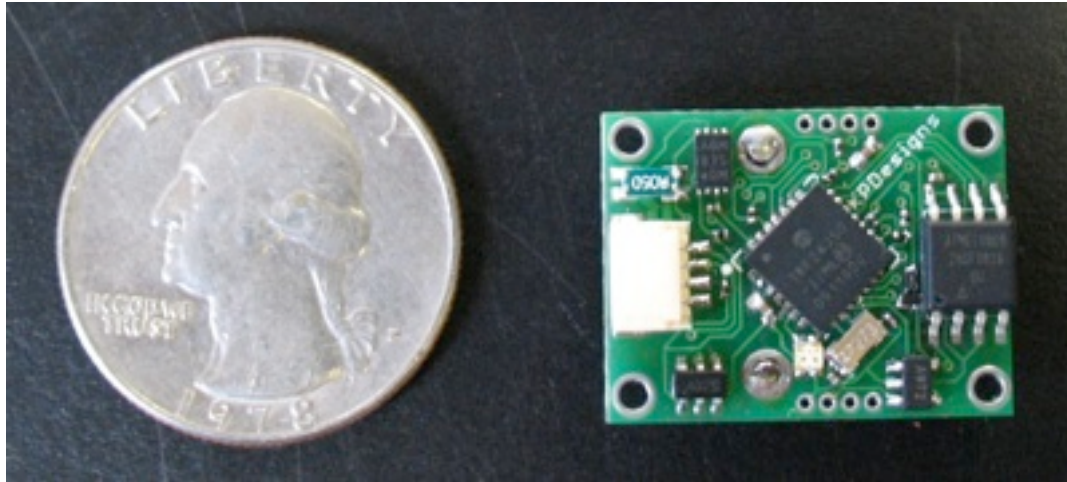
Off-grid Lighting Carbon Valuation:
\$ and tonnes per lamp

Avoided
CO₂
(tonnes)

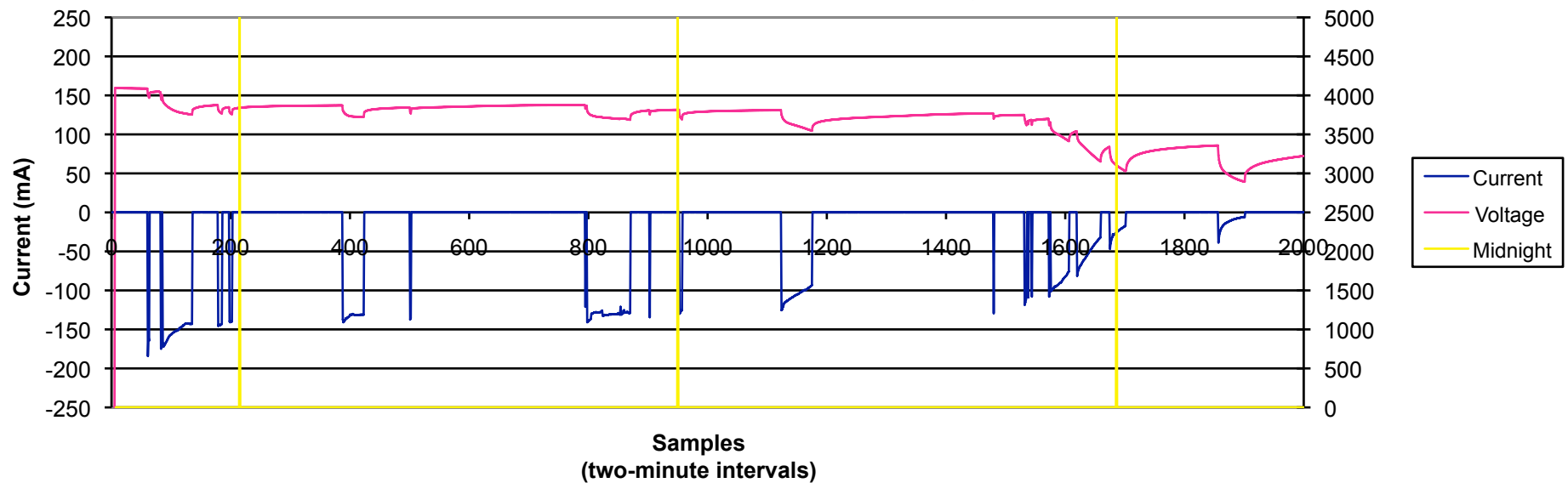


Source: Lumina Project (draft)

Development of micro data logger



Measured LED Lantern Usage over a Three-day Period: Africa



Source: Lumina Project (LBNL/HSU)

Scale-up:
Lighting Africa (\$12M)
DOE: Climate REDI / SLED (\$50M)

- More research
- Product testing
- Product rating/labeling
- Market data
- Business plan competitions
- Manufacturer incentives
- Carbon markets
- Industry association

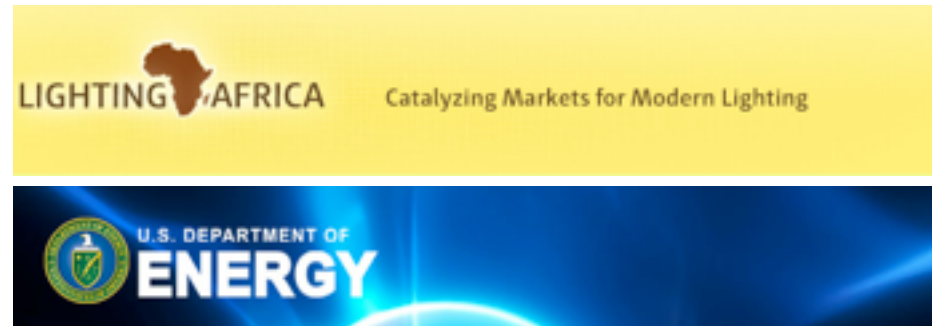




Photo: Rick Wilk

Thank you Art!

Thank you Blum Center for Developing Economies

Lumina Project Team: Arne Jacobson, Peter Johnstone, Kristen Radecsky, Jennifer Tracy, and Dustin Poppendieck at Humboldt State University. Jessica Granderson, Jim Galvin, and Francis Rubinstein at Lawrence Berkeley National Laboratory, and Maina Mumbi and Francis Ngugi in Kenya. Thanks to Michael Siminovitch at CLTC for early support!

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THE LUMINA PROJECT

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Cultivating Technologies and Markets for Affordable Low-Carbon Off-Grid Lighting in the Developing World

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Showing: Maai Mahiu Secondary School Environmental Club



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[Market Test with Night Vendors in Kenya](#)

[Product Testing](#)

[Indoor Pollution Measurements](#)



Google Map:

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